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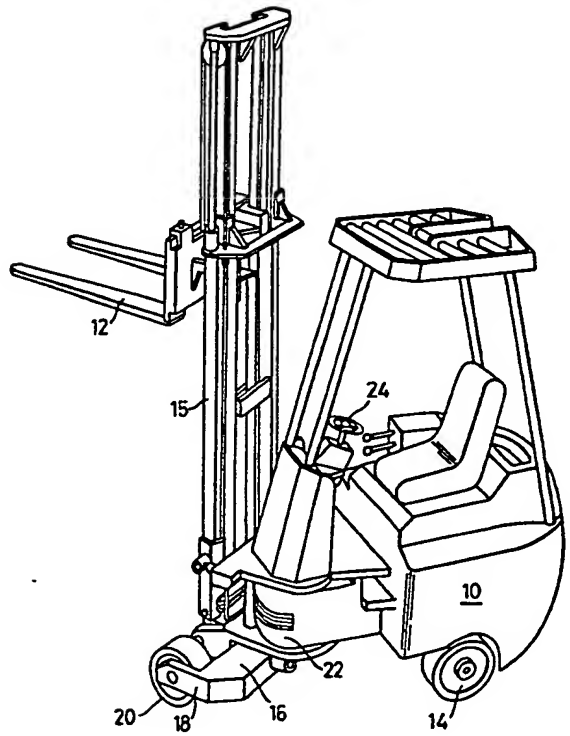
(54) Narrow aisle lift truck

(57) The truck has two articulated parts (10, 16) joined at a central pivot (22). In order to prevent tyre scrub when the parts are turned to an extreme position in which the centre of turning for example lies under the innermost one of the driven wheels (14) or even within the track of the driver wheels, each of the driven wheels has a separate driving motor and means are provided to stop or reverse the drive to the innermost wheel. The motors may be electric and powered by storage batteries.



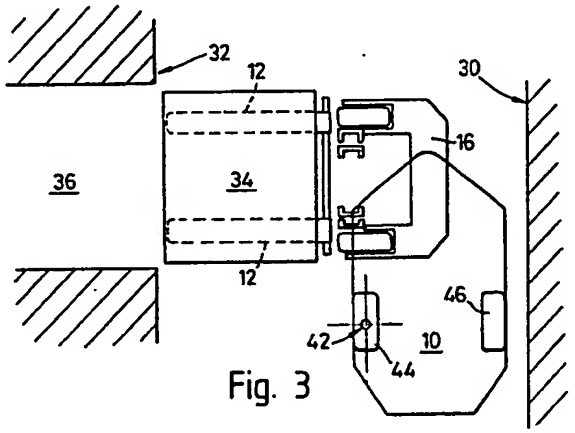


Fig. 3

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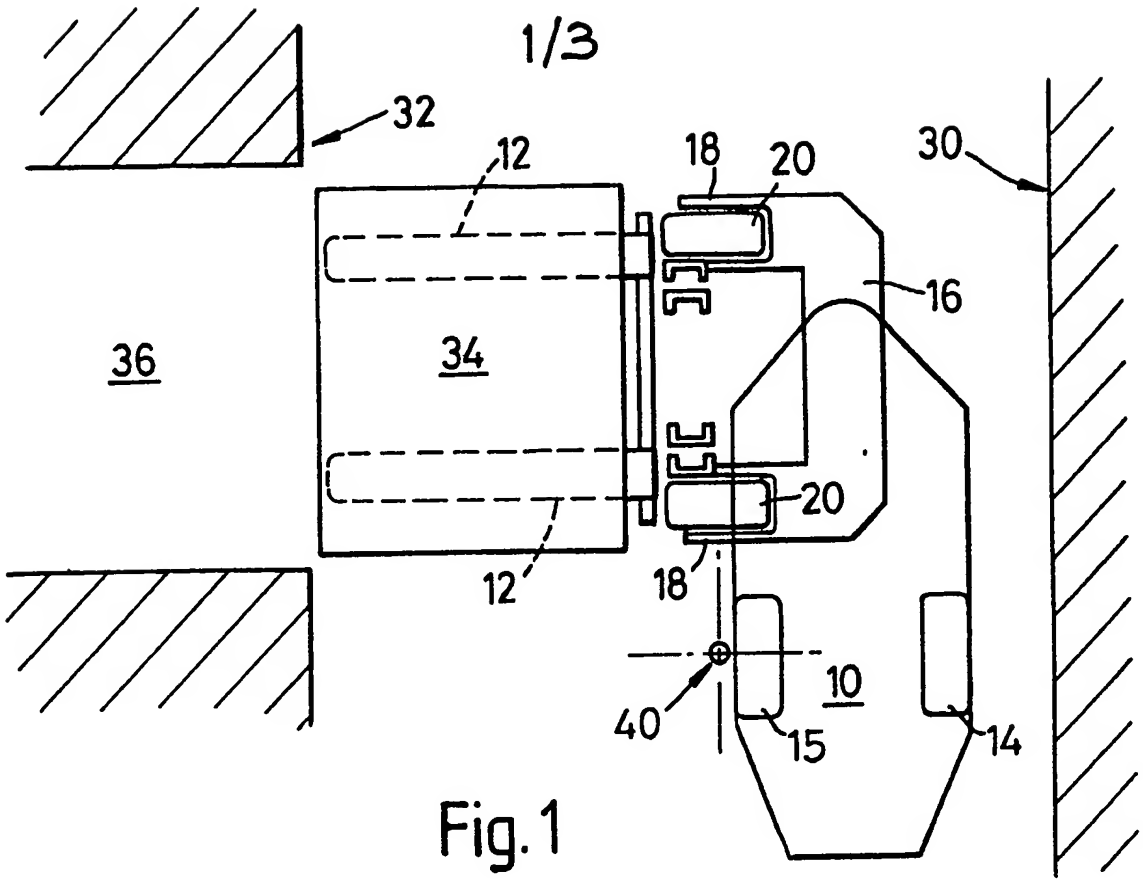
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Fig. 1

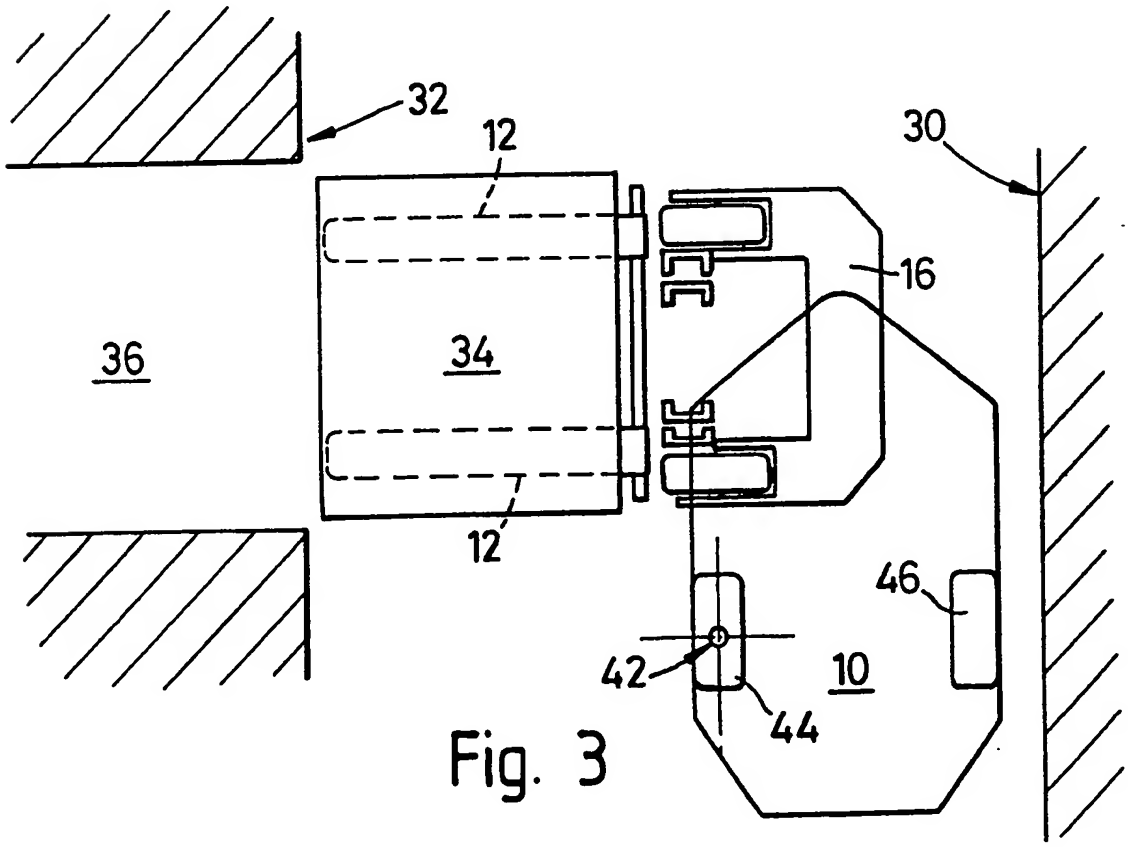
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Fig. 3

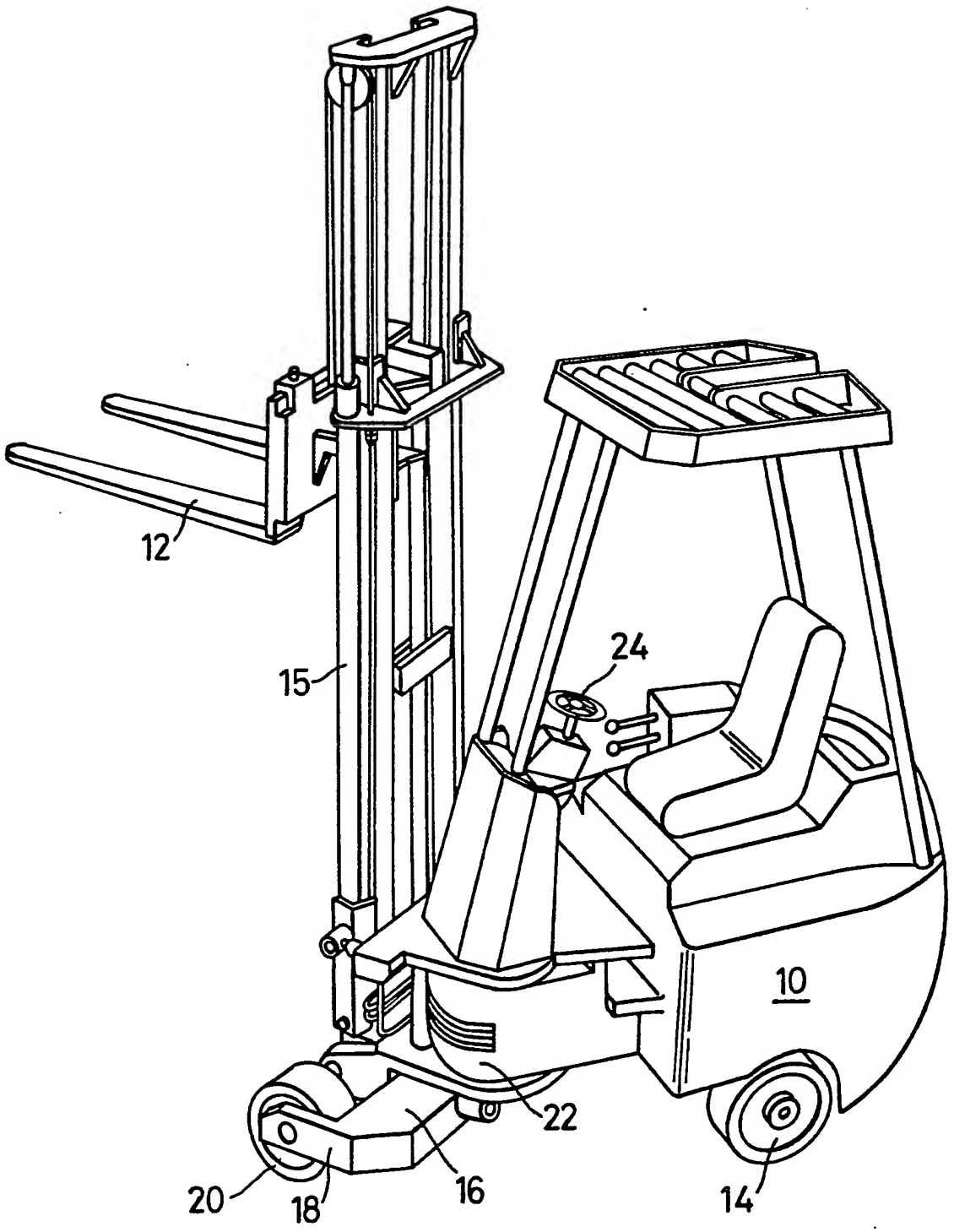

Fig. 2

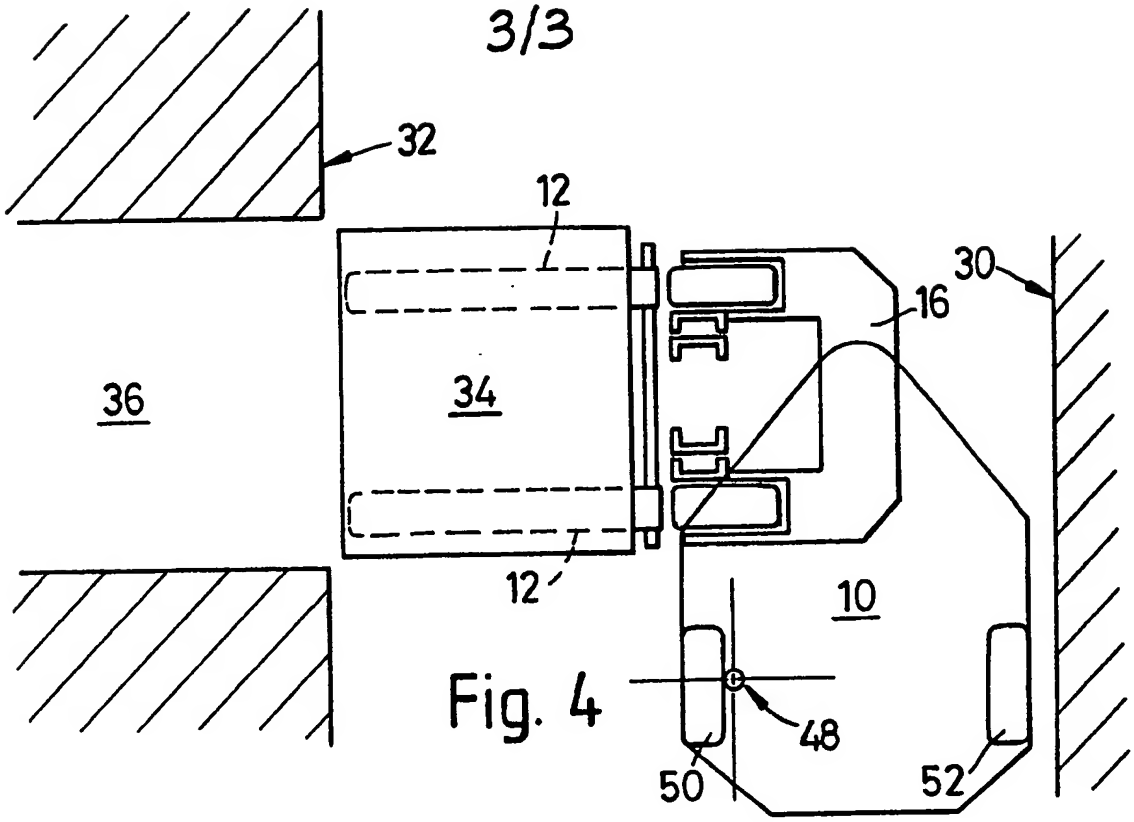

Fig. 4

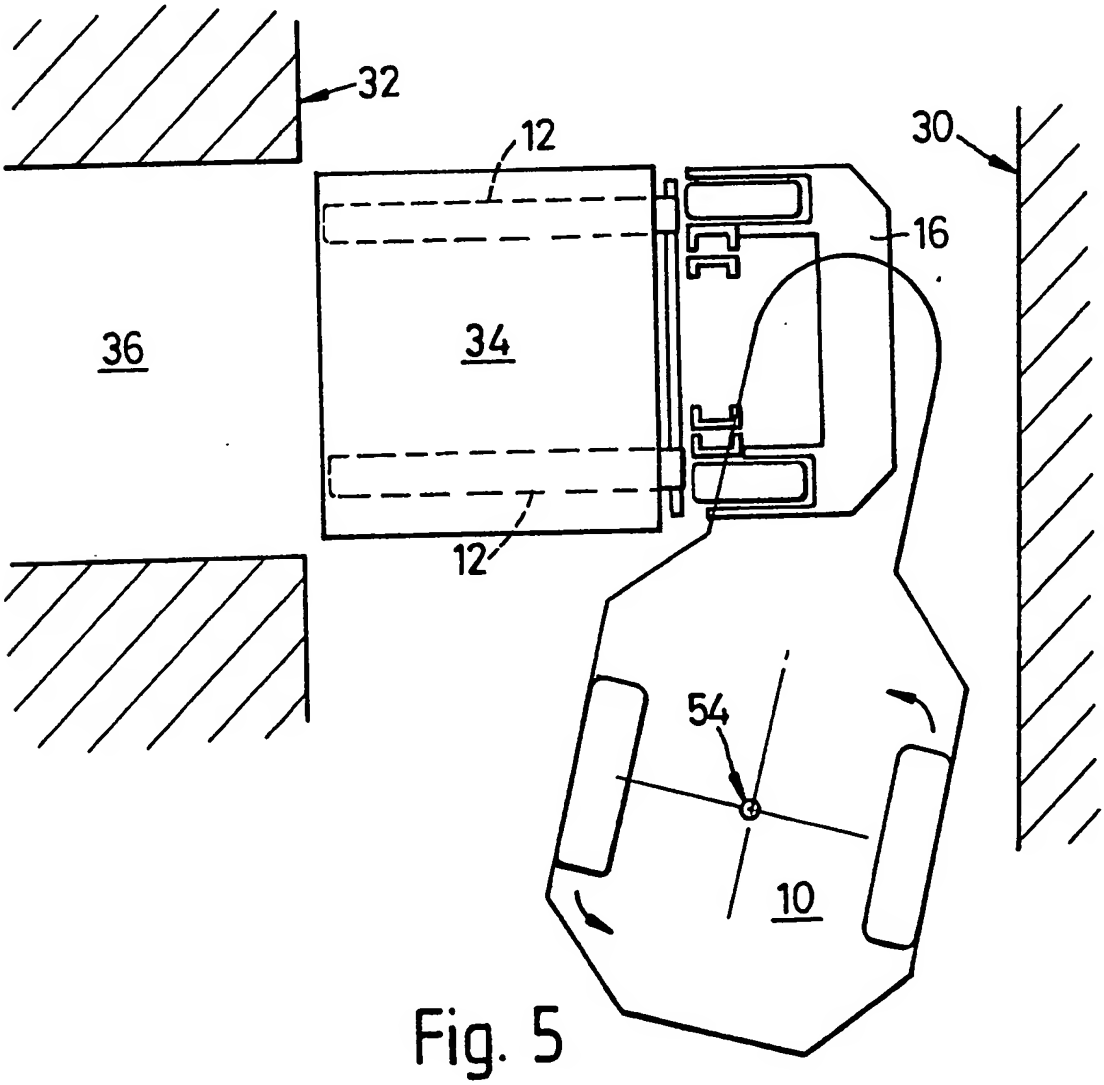

Fig. 5

NARROW AISLE LIFT TRUCK

EP 0 303 413 shows a narrow aisle lift truck having a body and a mast structure which are pivoted together about a main vertical or king pin axis. The body has wheels on a first common axis and the mast structure has feet with wheels on a second common axis. When the axes are parallel the parts are pivotally related for straight ahead, or straight back, travel. The mast has a carriage for elevation of forks which are for insertion and retraction of a load to and from the stack in which the aisle extends. Steering is effected by driving the mast structure about the king pin by any suitable means. A truck having all of these mentioned features is herein called "of the kind referred to".

A truck of this kind may, in an extreme position, have the said axes at an angle of the order of 90 deg. to one another. This can result in skidding and tyre wear. The object of the invention is to provide improvements.

According to the invention, a truck of the kind referred to is characterised by having a pair of driven wheels on a common axis on a first part, a second pair of wheels on a second axis on a second part, a mast on the second part with forks for elevating a load, together with steering means for turning the second part relative to the first part characterised in that the two driven wheels are provided with separate reversible driving motors and means are provided for stopping or changing the direction of rotation of one motor relative to the other according to the angle of turning caused by said steering means.

As the steering angle increases, the inner wheel may be driven at a slower speed then the outer one, and then disengaged from drive. Depending upon the geometry, it may then be driven in the opposite direction to the outer wheel.

For any one truck the choice depends upon the

geometry; and at any one time it depends upon the steering angle.

Preferably the two motors are under the control of circuitry (software) with an input from the steering wheel position, or from micro-switches contacted by parts of the steering gear, according to the angle of turning. The arrangement is most desirably such that in the straight line position both wheels are driven synchronously, and drive to the inside wheel - whichever one is involved according to the direction of turning - is progressively reduced as the radius of turning is reduced down to zero, or first down to zero then reversing of the inside wheel when the steering is near or is on full lock, according to the geometry and design of the truck.

It will be appreciated that when the truck turns and goes forward to the aisle side face the outer wheel is driven forwardly and the inner wheel is stopped or reversed; when the truck is reversed to withdraw from the aisle side face and straighten up, it is the outer wheel which is reversed and the inner wheel which is stopped or driven forwardly.

The second axis wheels may be located at the end of projecting feet, and in any event the design preferably allows the load to descend to ground level. Any projection may assist with stability to prevent the truck overturning especially when in extreme positions.

The possible geometry of the truck according to the invention may be considered thus: if the centre of turning, which is the intersection of straight lines containing the respective axes of the two pairs of wheels coincides with the ground contact point of the inside driven wheel, then drive of the outside wheel alone is possible with the inside wheel effectively pivoting on the ground. But if said centre is inside the track of the driven wheels then the inner wheel must turn backwards in relation to the outer wheel if extreme tyre wear and loss of control is to be prevented. However, in addition to avoiding or reducing tyre wear, the

arrangements according to the invention give advantages in manoeuvreing and maintains control of the vehicle at such times.

In said EP, the truck has an extensor mechanism for projecting the forks and load into and out of the stack at the side of the aisle. Such a mechanism requires to be particularly rigid in order to support adequate load in the fully extended position, and the effect of the extended load has to be taken into account in calculations relating to the potential stability of the truck. This places severe limits on the designer. In the present invention, the extensor mechanism can be avoided thus providing greater simplicity and rigidity in terms of mast, carriage and forks and increasing the limits of load carrying and transferring ability without incurring instability.

Such a simpler design, according to the invention, has relatively short projecting feet so as to allow for maximum movement of the load forks with the truck (instead of relative to the truck) in the direction transverse to the aisle e.g. for load insertion without coming into contact with the stack face of the aisle, and the same considerations apply in load extraction. Such short feet themselves tend to reduce truck stability, although the absence of the extensor mechanism increases stability to a greater extent. However, it is believed that the increased manoeuvreability and stability, together with the avoidance of the need for the load extensor retractor mechanism is a much greater advantage than the corresponding disadvantage of the need to provide control mechanism for varying wheel speed in relation to steering wheel position.

The invention is now more particularly described with reference to the accompanying drawings wherein:-

Figure 1 is a schematic plan view showing a prior art vehicle manoeuvreing in a narrow aisle;

Figures 2 is a perspective view of a truck according to the invention; and

Figures 3 to 5 are schematic plan views similar to

Figure 1 but showing three different trucks according to the invention.

Turning now to Figure 1 (prior art) this shows a truck provided with a pair of wheels (14 15) located on a common axis, and carried by a body portion (10) which is pivoted to a second part of the truck (16) having short forwardly projecting limbs (18) carrying a pair of non-driven wheels (20) located on a second axis. The part (16) is provided with a mast carrying forks (12) to support the load (34). This truck is primarily intended to be turned to the left only, and for this purpose wheel (14) is driven and wheel (15) is freely rotatable but not driven. The truck is shown in an aisle defined between a pair of parallel aisle faces (30 32) and it is manoeuvreing a load (34) for insertion into the space 36. If the load were to be inserted in the face 30, the truck would have to be driven round and positioned in the aisle facing in the opposite direction. The centre of turning of the truck is the point (40) which is the intersection of the axes of the front and rear wheels. It lies just outside the wheel base of the wheels (14 15). This truck had certain advantages in its manoeuvreability but it was tiring to drive because the steering was very heavy, and inconvenient in that it always had to insert and remove loads on the lefthand side of the vehicle when travelling in a forward direction.

Turning now to Figure 2, the truck shown comprises a first part (10) which carries the propulsion means for example storage batteries and electric motors together with the driver's seat and controls. The weight is concentrated rearwardly as low down and widespread as possible in the interests of stability of the truck especially when carrying a load on the forks (12). In considering stability it is to be recognised that the load may be elevated by the forks on the mast (15) and the latter may be telescopically height extendable in conventional fashion. The mast may be tilted back in conventional fashion when carrying the load, and of course stability needs to be considered when the truck is on full steering lock.

The first part of the truck has a pair of coaxial driven wheels (14), the overall width of which (track) plus the usual clearance dictates the aisle width of the warehouse or store in which the truck is to be used.

The second part of the truck (16) has short limbs (18) carrying the second pair of coaxial wheels (20). These may be of the same track as the wheels (14). The two parts (10 16) are pivoted together on a main vertical king pin or like in the part shown by the reference (22). Means are provided for turning the part (18) relative to the part (10) when the steering wheel (24) is turned in conventional manner.

The centre of turning in Figure 1 is shown as the point (40) which is intersection of the two axes of the respective wheel sets. As long as this point (40) lies outside the respective track dimensions the operation can be accomplished with the inner driven wheel merely turning at a lower speed than the outer driven wheel but in the same direction. The aisle width possible, with standard industry clearance relative to body width is shown to approximately correct scale in all of Figures 2-5.

Figure 3 shows the truck of Figure 2, that is one according to the present invention, but drawn to the same scale and in the same aisle location as Figure 1. In this case, because of the invention, the truck can be used to insert and remove loads to left or right, and the disadvantages with the truck of Figure 1 are avoided. Additionally, it will be noted that the proportions of the truck can be changed whilst working within the same set of parameters as to load, size and weight and aisle width. In particular the truck can be made wider thus increasing stability. In this case the centre of turning (42) lies in the central point of contact of the inner wheel with the ground. This wheel (44) is then held stationary insofar as rotation about its axis is concerned whilst the outer wheel (46) drives forwardly for load insertion, or rearwardly during load removal.

It will be understood that if inserting or removing a load from the opposite side, the centre of turning will lie under the wheel (46) and that will be the wheel which is disengaged from drive and or driven rearwardly during load insertion.

Figure 4 goes one step further. Again keeping all other things equal the track is still wider, the stability/load possibility is increased, and the centre of turning now lies within the track, that is between the wheels (50,52). In this position inner wheel (50) needs to be driven in the reverse direction relative to the outer wheel for the operation.

Figure 5 shows a modification of the Figure 4 arrangement when the two parts are arranged to be capable of being turned through more than 90deg. The centre of turning (54) can now be brought to the midpoint of the driven wheel track, so that again by driving the wheels in opposite directions but now possibly at the same speed instead of driving the inner wheel in the opposite direction at reduced speed, the load can be moved laterally of the aisle in the final part of the load insertion, or the initial part of the load removal operation.

CLAIMS

1. A forklift truck having a pair of driven wheels (14) on a common axis on a first part (10), a second pair of wheels (20) on a second axis on a second part (16), a mast (15) on the second part with forks (12) for elevating a load, together with steering means (24) for turning the second part relative to the first part characterised in that the two driven wheels (14) are provided with separate reversible driving motors and means are provided for stopping or changing the direction of rotation of one motor relative to the other according to the angle of turning caused by said steering means.

2. A truck as claimed in Claim 1 wherein the maximum steering angle results in the centre of turning (42) of the truck (the point where extensions of the axes of the respective pairs of wheels intersect) lying in the area of contact of the innermost wheel (44) with the ground, and the arrangement is such as to stop the motor driving said inner wheel at said maximum steering angle.

3. A truck as claimed in Claim 1 wherein the maximum steering angle results in the centre of turning (48) of the truck lying within the track width of the driven wheels and the arrangement is such as to reverse the motor driving said innermost wheel (50) at said maximum steering angle.

4. A truck as claimed in Claim 3 wherein the maximum steering angle of the truck results in the two parts of the truck being related at an acute angle and the centre of turning (54) lies midway between the driven wheels.